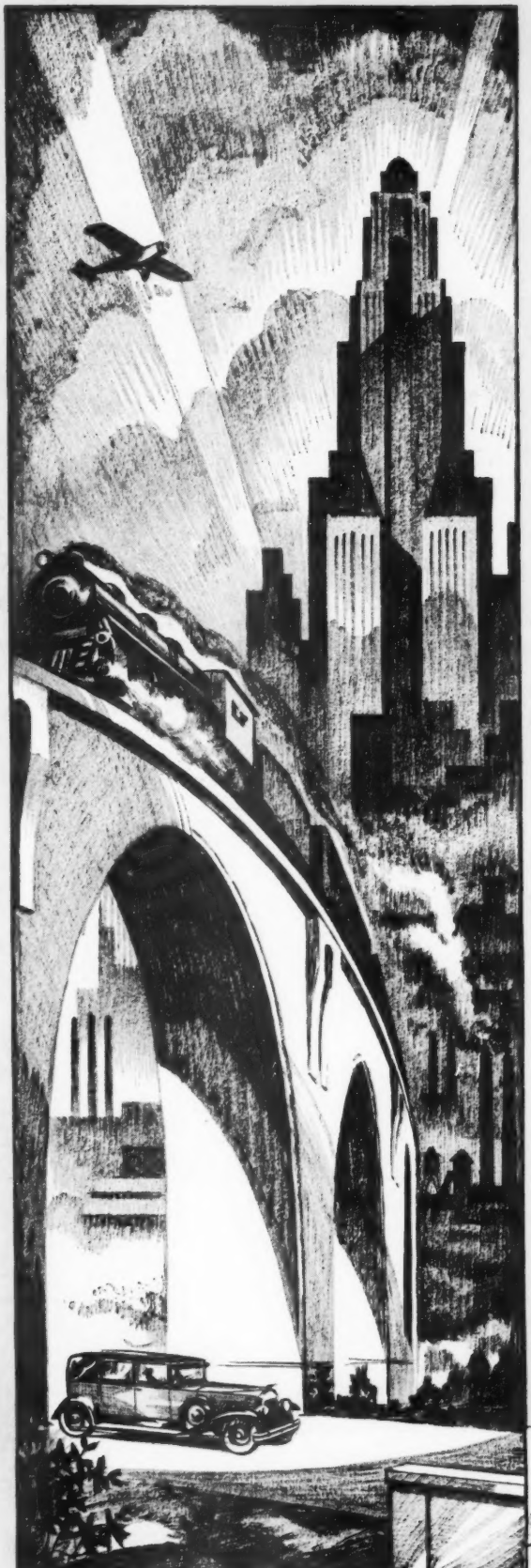

The CRUSHED STONE JOURNAL

In This Issue

April • 1931

Official Publication
NATIONAL CRUSHED STONE ASSOCIATION

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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

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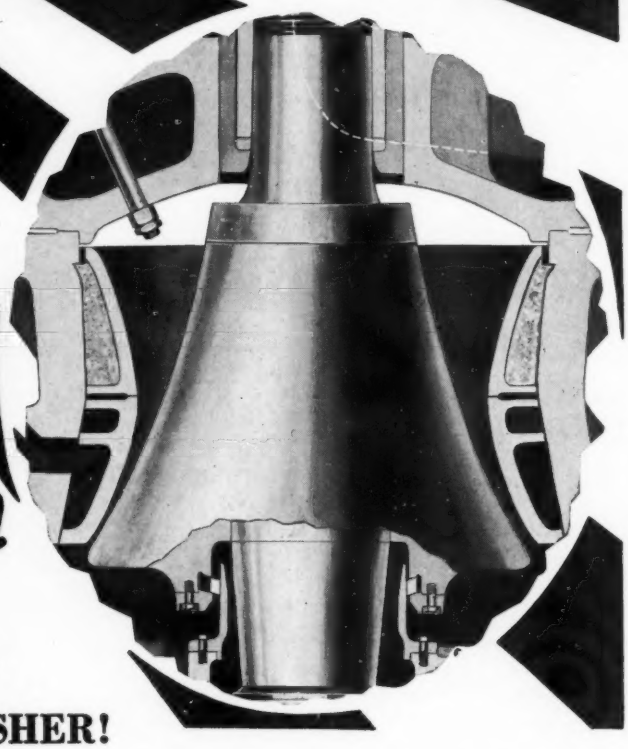

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Freezing Tests on Mortar and Concrete

By A. T. GOLDBECK
Director, Bureau of Engineering, National Crushed Stone Association

♦ Engineers are rapidly recognizing that soundness is an important characteristic of the aggregates and materials used in concrete construction. Too frequently concrete structures show evidence of lack of durability. In such cases does the fault lie with the aggregates, with the cement, with the methods of construction or with other influences? There is a rapidly growing tendency to include in specifications some form of accelerated soundness test, and there is probably no more important problem confronting the stone producers today than the development of a proper soundness test which will truly indicate the condition of soundness of their material. The following series of investigations, conducted in the research laboratory of the Association, contributes some illuminating information on this subject.

UP to comparatively recently, the soundness of aggregates entering into concrete construction was almost never brought into question. Today, however, almost every engineer who deals with concrete construction thinks of the possible unsoundness of the materials which he is using and very rapidly some form of accelerated soundness test is being written into specifications for aggregates. There is no more important problem confronting the stone producer today than that of having a proper soundness test developed which will truly indicate the condition of soundness of his material.

The so-called sodium sulphate test for soundness is being used and yet, unfortunately, there is no information available which really permits of the proper interpretation of this test in terms of the actual service behavior of the rock. Some engineers determine the soundness of rock as the result of its behavior after five alternations of the sodium sulphate test; still others require that the rock be required to pass 10 alternations of this test. There is no uniform method of conducting the test and, moreover, there is no standard way of determining the degree of unsoundness of the sample after it has been subjected to the required number of alternations.

Further, there are instances in which the sodium sulphate test causes disintegration of material which is sound in actual service. The reverse is also true. Materials which are unsound in service are found to be sound when tested in the sodium sulphate test, according to reports from authoritative sources. It is seen, therefore, that the testing of rock for soundness is in a state of chaos and this is bad from both the standpoint of the producer and of the consumer. The devising of a suitable sodium sulphate soundness test is only one of the problems connected with soundness, however. Suppose a concrete structure disintegrates. The question immediately arises as to what was the cause of this disintegration. Was it the coarse aggregate? Did the fault lie with the fine aggregate? Was the cement at fault? Was too much water used in the mixture, thereby creating a concrete which was too porous and too weak to withstand the internal disrupting action of ice? Is mortar any more sound than the fine aggregate, or the coarse aggregate ordinarily used in concrete? Is the cement itself as sound as either the fine or the coarse aggregate? If rock does exhibit some degree of unsoundness, what may its unsoundness be before it becomes unsuitable for use as a coarse aggregate in concrete? Should the character of the accelerated soundness test not be varied depending upon the degree of exposure of the rock in service? Do we need as severe a soundness test for rocks used in the southern part of the United States as compared with rock used in the extreme North where the frost action is severe? These and many other questions remain to be solved in connection with this most important matter of soundness.

One of the questions of great interest to stone producers is the amount of water which may safely be used in concrete containing crushed stone as a coarse aggregate. How high a water-ratio is safe? By

water-ratio is meant the ratio of the volume of water to volume of cement used in the mix. Only a certain proportion of the water added to concrete is necessary for the hydration of the cement. The remaining water

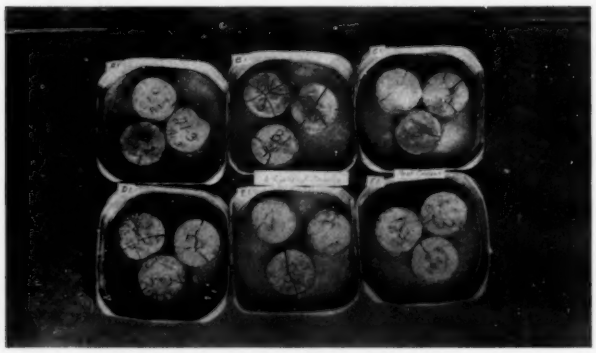

FIGURE No. 1-A—Neat cement, Series I, after 3 cycles of freezing and thawing.

is required to give the concrete sufficient mobility for its proper placing and this excess water later disappears. It is this water which leaves voids within the concrete into which water subsequently enters and renders frost action effective. The smaller the amount of these void spaces, that is, the smaller the amount of the free water in concrete, the more durable is that concrete apt to be.

This question of durability of concrete is so important that we thought it necessary to investigate it quite thoroughly and for this purpose a number of mortar mixtures were made, varying from neat cement to mixtures as lean as 1:3. Specifically, these mixtures were composed of neat cement, 1:1, 1:1½, 1:2, 1:2½, and 1:3 mortar by volume. Not only were different proportions of mortar used but also different

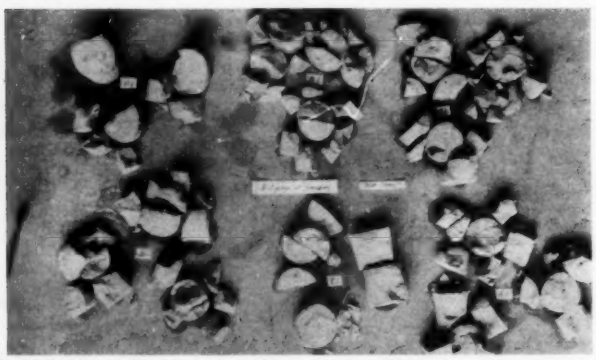

FIGURE No. 1-B—Same as Figure 1-A after removal from pan.

water-ratios, for we wished to study the effect of mixtures having different degrees of wetness. These water-ratios were as follows:

0.63	0.84
0.70	0.91
0.77	0.98

This resulted in 36 different mixes. Three series of specimens were made in which each series consisted of 36 mixes and the variation between the series was in the method of curing. All of the mixes were made with a standard brand of Portland cement which complied with the standard requirements, washed Potomac River sand and city mixing water. The sand had the following gradation:

Total Retained (per cent)	First Series (per cent)	Second and Third Series (per cent)
4	0	4
8	18	22
16	30	37
30	46	54
50	82	83
100	97	96
200	98	98
Fineness modulus	2.73	2.96

Potomac River sand is composed essentially of particles of quartz, chert and sandstone, and is resistant to freezing and thawing and to the action of sodium sulphate.

In the first series three specimens of each mix were molded in wax paper cups. The wet mortar was constantly agitated during molding to prevent segregation. Immediately after molding, the specimens were covered to prevent evaporation. In the second and third series, the method of molding was the same as in the first series except that jelly glasses were used as molds. Six specimens were made for each mix.

Methods of Curing

The following methods of curing were used:

First Series: 14 days in moist air, 12 days in dry laboratory air, 1 day in oven and 1 day in water.

Second Series: 14 days in moist air, 13 days in dry laboratory air, 1 day in water.

Third Series: 28 days in moist air.

Series I

The specimens were tested by freezing and thawing. Three specimens of each mix were placed in a pan and the pan was partially filled with water. The specimens were then placed in an electric refrigerating cabinet for 24 hours. The average temperature of this cabinet was −3° F. After freezing, the specimens were allowed to thaw 24 hours in the laboratory air.

Result of Freezing and Thawing—the First Series

All of the specimens of this series were oven dried for 24 hours. On removal from the oven it was observed that the neat cement specimens had developed shrinkage cracks. Three freezings opened these cracks quite appreciably as may be seen from the photograph,

(Fig. 1). Six freezings showed the neat cement completely broken up and disintegrated. After ten freezings all of the specimens had failed and the test was discontinued. The mortar specimens of this series de-

FIGURE No. 2—1:1 Mortar, Series I, water ratios of 0.63, 0.70 and 0.77, after 35 cycles of freezing and thawing.

veloped no cracks on account of drying in the oven. In the freezing tests none of the specimens cracked like the neat cement specimens; the failure was that of continuous surface disintegration. At first there occurred chipping or scaling of the richer mortars and a slight crumbling of the leaner mortars. Then followed a continuous loosening or softening of the cement paste on the exposed surface, the larger grains of sand projected above the surface until the surrounding face had softened and fallen away.

A study of the accompanying photographs, Figs. 2 to 6 will show the disintegration which took place. The neat cement specimens were considered to have utterly disintegrated at ten cycles and therefore these specimens were discontinued. The other specimens were continued up to fifty cycles and at various intervals specimens were discontinued because of their advanced stage of disintegration. The appearance of the specimens in Series I after 35 cycles of freezing and thawing is shown in Figs. 2 to 6.

It is to be noted that the 1:1 and 1:1½ specimens

FIGURE No. 3—1:1½ Mortar, Series I, water ratios of 0.63, 0.70 and 0.77, after 35 cycles of freezing and thawing.

1:3 specimens of mortar. Also the wet mixes are disintegrated much worse than the dryer mixes. In a are much more badly disintegrated than the 1:2½ and very general way, it will be seen that the stage of disintegration follows more or less the water-cement-ratio used in the mixture. However, the water-cement-ratio is not, strictly speaking, an index of the probability of disintegration because it is seen that the lean mixtures have not disintegrated as badly as the rich mixtures and yet the same range of water-cement-ratios was used in the lean mixtures as in the rich mixtures.

When water is mixed with cement, only a portion of it is necessary to hydrate the cement and the remaining portion of the water must disappear when it evaporates and it must leave voids in the hardened mass. That portion of the mixing water which is not used in hydrating the cement and which would disappear upon evaporation might be known as "free" water. It would seem that the higher the percentage of voids remaining in a mortar due to evaporation of the free water, the less durable that mortar would be and, accordingly, in order to investigate this possibility, the percentage of free water in all of the mixtures in Series I was calculated and these percentages are given in Table No. I.

TABLE I

Per Cent Free Water in Mortar Mixtures

$$\text{Per cent Free Water} = \frac{\text{Weight immediately after molding minus oven dry weight}}{\text{Oven dry weight}} \times 100$$

W/C	1 Neat Cement	2 1:1	3 1:1½	4 1:2	5 1:2½	6 1:3	
0.63	21.5	10.9	8.9	7.3	8.8	11.3	A
0.70	24.4	13.0	10.4	8.3	7.2	9.8	B
0.77	27.5	14.9	12.1	10.3	8.6	8.0	C
0.84	29.6	15.6	12.7	11.2	8.8	7.8	D
0.91	29.8	17.6	14.7	12.5	9.6	8.9	E
0.98	32.6	18.6	16.0	13.5	11.5	10.4	F

FIGURE No. 4—1:2 Mortar, Series I, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

This table, when studied in comparison with the photographs in Figs. 2 to 6, showing the results of the freezing and thawing after 35 alternations is exceedingly interesting. The table shows that the neat cement specimens had very high percentages of free water and those specimens disappeared from the test at the end of 10 alternations of freezing and thawing. They had completely disintegrated at that period. It will be seen that the higher the percentage of free

water, the more completely had disintegration taken place in practically all of the specimens. The 1:3 specimens, in general, have a comparatively low percentage of free water and they have stood up remarkably well. The 1:2½ mortar series is interesting in showing that the particular specimens which show the worst disintegration had the very highest percentage of free water, that is specimens F-5 with a water-ratio of 0.98.

FIGURE No 5.—1:2½ Mortar, Series I, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

From this study it seems to be very strongly indicated that the free water content controls the durability of mortar, certainly within the range of specimens used in this particular investigation. It might be objected by some critics that rich mortars are those which ordinarily stand up in service much better than lean mortars and, in general, this is perfectly true and in this sense seems to contradict the results of Series I. On the other hand, it must be remembered that when concrete is made for structural purposes it ordinarily is made to a given consistency and it requires much less water in a rich mix than in a lean mix to make concrete of the desired consistency. Therefore in service, rich concretes are apt to have a low water-cement-ratio as compared with lean concretes.

FIGURE No. 6—1:3 Mortar, Series I, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

In the present series of tests, on the other hand, all of the mortars had exactly the same range of water-cement-ratios; therefore, they did not have the same range of consistencies. The neat cement and the rich mortars, for illustration, were almost of a soupy consistency, whereas the 1:3 and the 1:2½ mortars varied from dry to wet but they were not soupy. Had these mortars been made to a given consistency as in service, in all probability it would have been shown that the rich mortars were more durable than the lean mortars.

The specimens in Series I were subjected to a condition which is not natural to service in that they were dried in an oven in order to determine their moisture content. Concrete or mortar in service does not have such exposure to heat. It was noticed that the neat cement pastes after removal from the oven were very badly cracked due to shrinkage and it was shown that the rich mortars had likewise suffered correspondingly from undue shrinkage. It was, therefore, decided to try still another series of tests which would more nearly stimulate service conditions.

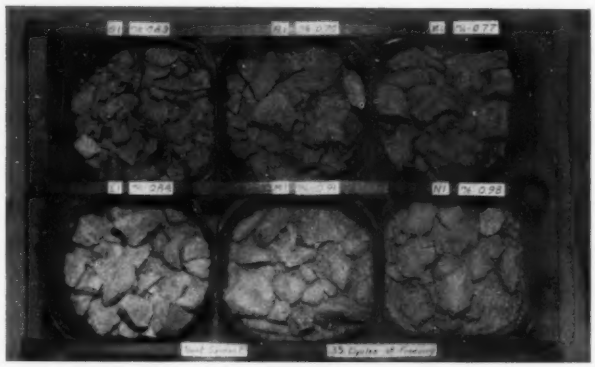

FIGURE No. 7—Neat Cement, Series II, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

FIGURE No. 8—1:1 Mortar, Series II, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

Series II

In Series II the materials, the water-cement-ratios and the mixes were the same as in Series I, but in the second series the specimens were cured 14 days in the moist room; they were then allowed to dry in air for 13 days after which they were placed in water one day. In the third series the specimens were cured

continuously in water or rather in the moist room 28 days. The specimens in the second series, having been exposed to the air 14 days, were air-dried and the neat cement specimens developed shrinkage cracks just as did those in Series I dried in an oven. At the end of ten cycles of freezing all of these neat cement specimens had broken into many small pieces and at 35 cycles the broken pieces were disintegrated in about

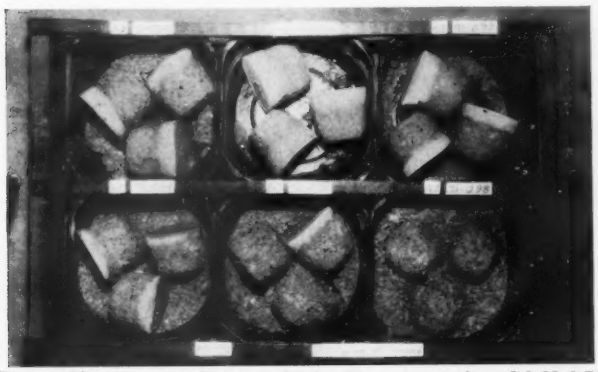

FIGURE No. 9—1:1½ Mortar, Series II, water ratios of 0.63 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

the order of their water-cement-ratios, the high water-cement-ratio being the most readily attacked.

A study of the illustrations, Figs. 7 to 12, after 35 cycles of freezing, in comparison with Table I will show in a general way that the resistance of disintegration has some relation to the free water content, although this relation does not seem to be exact.

FIGURE No. 10—1:2 Mortar, Series II, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

Series III

The specimens in Series III, as before stated, were cured continuously in the moist room and if a comparison is made at 35 cycles, Figs. 13 to 18, respectively, with corresponding examples of Series II, there seems to be no marked improvement in the water cured specimens, except possibly in the case of the neat cement specimens. At the end of 35 cycles practically all of the specimens were in a bad state of disintegration but in all three series, those having a water-ratio of 0.91 and 0.98 were rather outstandingly the worst specimens of the lot. Richness of mortar does not seem to have any particular effect on the durability when the water-ratios are about alike.

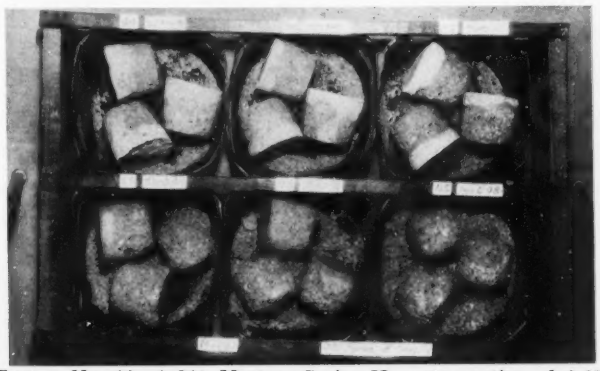

FIGURE No. 11—1:2½ Mortar, Series II, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

One of the outstanding features of this test was the fact that practically all of the mortars made, disintegrated badly in a comparatively few cycles of freezing and thawing and yet, the sand from which these mortars were made, Potomac River sand, withstands freezing and thawing and also the sodium sulphate test without disintegration of its particles. In other words, it is quite possible to have disintegraton of mortars and therefore of concrete, even with fine aggregates which are in themselves sound.

Freezing Tests of Sands and Gravels

Five glacial sands and gravels whose durability had been questioned were submitted for test. A sample

PERCENTAGE UNSOUND

No.	154	155	156	157	158
Gravel	62	54	77	16	31
Pea Gravel	48	38	77	53	22
Sand	questionable	questionable	unsound	questionable	questionable

of gravel, pea gravel and sand was received from each source of supply. Ten cycles of freezing showed a large percentage of the gravel samples to be unsound

FIGURE No. 12—1:3 Mortar, Series II, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

as may be observed in Fig. 19. Twenty-five cycles of freezing gave results as shown in above table.

The sand was further tested by making mortar specimens similar to those of Series II. Three specimens

from each sand were made in a 1:2 mix and a water-cement-ratio of 0.70. These were cured 14 days in moist air, allowed to dry in the laboratory air for 12

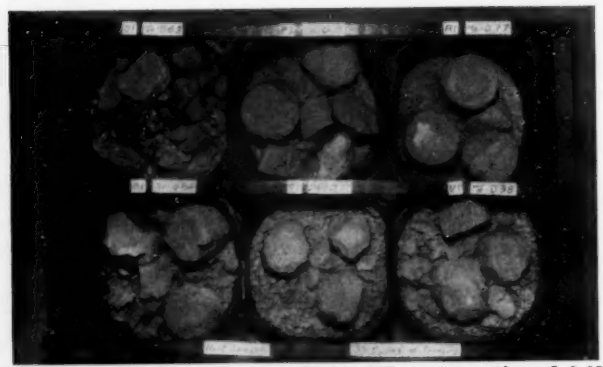

FIGURE No. 13—Neat Cement, Series III, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

days then partially immersed in water for 2 days, after which freezing and thawing tests were made. Every one of these specimens after 50 cycles of freezing was practically sound. There was some slight chipping on the bottom of some of the specimens but it was of minor consequence. After 70 cycles of freezing (Fig. 20) No. 158 had chipped an appreciable amount and the remaining specimens were sound. Also, it is to be noted that there was no softening of the mortar such as occurred in the first three samples just described in which the sound Potomac River sand had been used, nor was there any puffing or cracking of the mortar caused by the unsound fragments in the sand. Even after 70 cycles of freezing and thawing

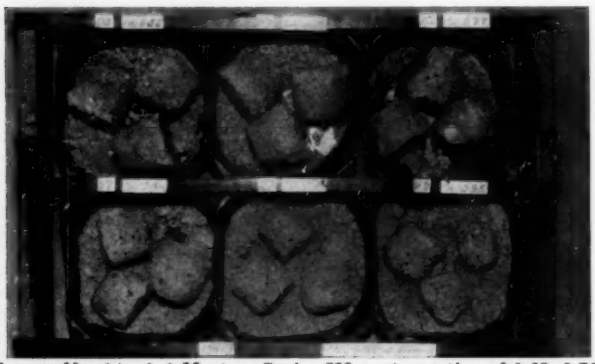

FIGURE No. 14—1:1 Mortar, Series III, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

these samples made with so-called unsound sand were incomparably better than those made with Potomac River sand supposed to be sound. If these tests are at all indicative, they show that the durability of sand is not necessarily an indication of the durability of mortar. For the sake of completeness, the gradation of the five glacial sands is given in Table II.

TABLE II—GRADATION OF FIVE GLACIAL SANDS

Total Retained	154	155	156	157	158
No. 4	6	5	7	13	8
8	20	22	28	31	26
16	31	46	51	47	41
30	44	70	74	68	50
50	74	91	90	90	65
100	96	98	97	98	96
200	99	99	98	99	100
Fineness modulus	2.71	3.32	3.47	3.47	2.86

The Effect of Questionable Coarse Aggregate on the Soundness of Concrete

The question frequently arises, what effect does unsound stone have on the quality of concrete? One series

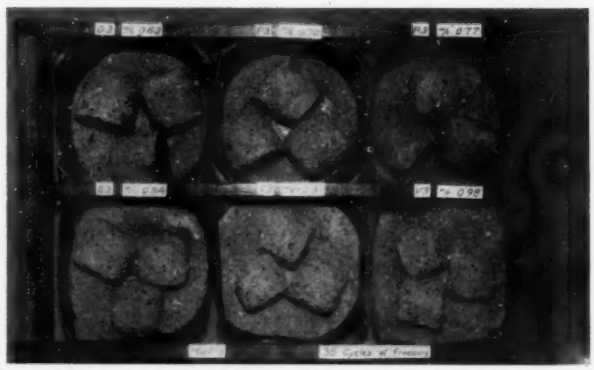

FIGURE No. 15—1:1½ Mortar, Series III, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

of tests made during the past year throws some light on this question. In Fig. 21 is shown the effect of 10 cycles of freezing on a sample of stone received in our laboratory. Surely, material having as much disintegration as shown after 10 cycles would be considered unsound, if judged by this test alone. In Fig. 22 is shown the effect of 85 cycles of freezing and thawing on concrete made from the same stone. It will be seen from the photograph that the effect of the freezing has been to remove the surface mortar from the concrete and the coarse aggregate projects beyond the mortar, showing that it at least is as sound, if not more so, than the mortar itself. This is so, not only in concrete made with the so-called unsound stone, but

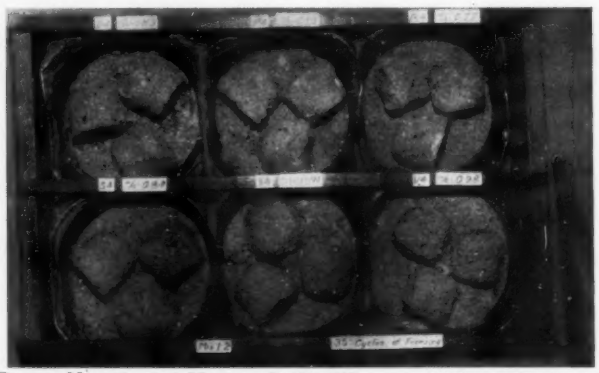

FIGURE No. 16—1:2 Mortar, Series III, water ratios of 0.63 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

it is true also of the concrete made with sound stone.

In Fig. 23 are shown four samples of concrete, the first three of which samples, numbers 7, 9 and 13, were made with aggregate which might be open to

some question if judged by the sodium sulphate test alone. Sample No. 35, on the other hand, would be considered sound. Samples numbers 9 and 13 would be considered exceptionally unsound as tested by the

FIGURE No. 17—1:2½ Mortar, Series III, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing.

sodium sulphate test and yet, when made into concrete and exposed to 75 alternations of freezing, as shown in the accompanying figure, the appearance of the specimens is about alike. In all cases the mortar has disappeared from the surface and has exposed the aggregate. The data on the mixtures used in this series are as follows:

Mix—1:2:3½ by loose volume.

Sand—Potomac River sand with a fineness modulus of 2.82.

The following data apply to the concrete mixtures.

No.	W/C	Bags of Cement per. Cu. Yd.	Coarse Aggregate
7	0.88	6.08	Dolomite
9	0.86	5.94	Marble
13	0.88	6.13	Limestone
35	0.80	6.10	Limestone

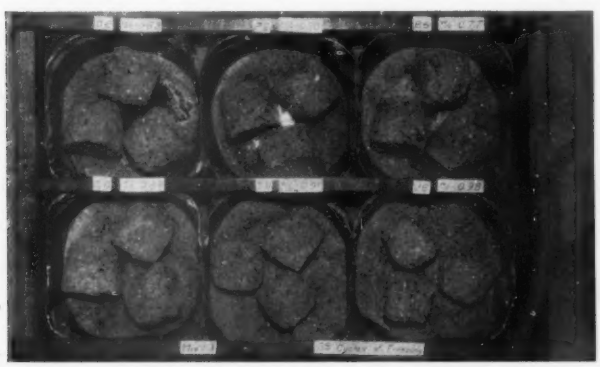

FIGURE No. 18—1:3 Mortar, Series III, water ratios of 0.63, 0.70, 0.77, 0.84, 0.91 and 0.98 after 35 cycles of freezing and thawing

After the mortar disappeared from the specimens, entirely exposing the coarse aggregate, there was a tendency for the unsound portion of the aggregate to flake off to some extent, but it did not break the concrete, nor did it cause pitting on the surface of the concrete.

Investigation of Unsound Concrete

In Fig. 24 is an interesting case of a diagnosis of concrete which failed at the end of one year. A sample of concrete was sent to the laboratory to determine, if possible, what was the cause of the failure and our first procedure was to determine if the failure

FIGURE No. 19—10 cycles of freezing on gravels, showing sound and unsound portions.

was due to the coarse aggregate or to the mortar. We were primarily interested in whether the coarse aggregate was at fault, and the first step was to separate the mortar from the coarse aggregate. After this was done and the coarse aggregate was cleaned, both the mortar and the coarse aggregate were subjected to

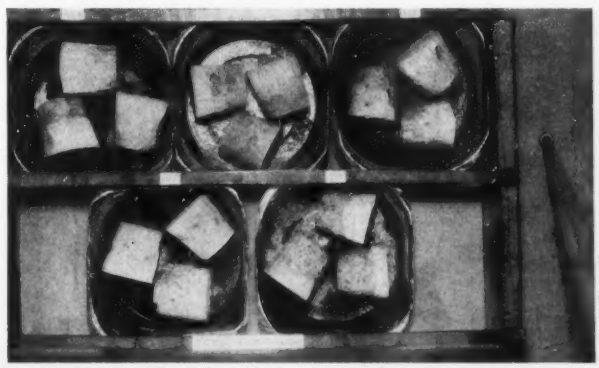

FIGURE No. 20—Freezing tests on 1:2 Mortar, 0.70 water ratio, using sands from same deposits as gravels shown in Figure 19.

alternations of freezing and thawing. Fig. 24 shows the appearance of the stone and of the mortar after only 7 alternations of freezing and thawing. It is to be noted that the stone portion of the concrete still remains intact but the mortar has utterly disintegrated, showing that if any portion of the concrete was at fault it most assuredly was the mortar. In view of the fact that we did not have the separate materials in the mortar, that is, the cement and the sand, we were unable to proceed further to determine which of each of these materials was faulty.

Conclusions from Soundness Investigations

From the data presented no definite conclusions can be drawn. On the other hand, there are certain indications that are worthy of note. These are as follows:

1. Sound Portland cement when mixed with water alone in water ratios of 0.63 to 0.98 is not always a sound material when subjected to freezing.
2. It is possible for rich mortars to fail and lean mortars to possess a good degree of durability. Also the reverse of this is true. Much depends upon the "free" water in the mixture.
3. Tests indicate that it is possible to have an unsound mortar with a "sound" sand and a sound mortar with an "unsound" sand, each having the same water-cement ratio.
4. Coarse aggregate, even though in some cases unsound, does not necessarily make for unsoundness in concrete. The unsound stone tested did not crack the concrete, nor did the stone leave the concrete or cause pitting. Only after the mortar had failed did the stone fail by continuous chipping.

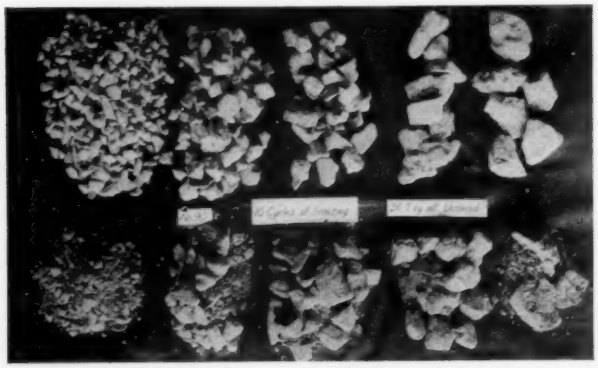

FIGURE No. 21—10 cycles of freezing on various limestones, showing sound and unsound portions.

FIGURE No. 22—Appearance of concrete after 85 cycles of freezing. Although stone number 90 is not resistant to freezing and number 59 is resistant, the concretes have about equal resistance.

5. The cementing medium, composed of Portland cement and water, seems to be a most important element in the durability of concrete. It is highly important that the water content be kept low.

Durability tests are the most important tests that can be made on concrete and concrete materials today. Our investigations and those of other laboratories with respect to durability have only begun. There remains much to be discovered and particularly is it important to obtain facts that will permit of writing specifications for aggregates and for concrete which will insure their durability.

FIGURE No. 23—Concretes after 75 cycles of freezing. The resistance is similar in all cases notwithstanding a wide difference in resistance to freezing of the stone aggregates in the various specimens.

FIGURE No. 24—Freezing test on unsound concrete. The mortar and stone were first separated. After 7 cycles of freezing the mortar had disintegrated while the stone was entirely sound.

Cement Production for March Still Shows Decline

AMERICAN Portland cement mills show a decline in the ratio of operation to capacity as indicated by the figures for the twelve months' period ending March 31. According to statistics released recently by the Bureau of Mines of the Department of Commerce, the ratio of operations to capacity for the last twelve months was 58.6 per cent. The ratio percentage for the twelve months ending March 31, 1930, was 66.1 per cent, and for the twelve months ending March 31, 1929, was 70.9 per cent.

New Developments in Bituminous Road Construction[1]

By PREVOST HUBBARD
Chemical Engineer, The Asphalt Institute,
New York, N. Y.

◆ With the increase in popular favor of bituminous types of road construction and the consequent increase in usage of such types, it behooves those interested in the highway construction field to keep informed with regard to the new developments which are rapidly taking place in connection with these types. The following article by Prevost Hubbard, one of the leading authorities on bituminous materials, should prove particularly informative.

THE subject of this paper makes it unnecessary to review those details of construction of the various types of bituminous pavements and surfaces which are most commonly known and practiced. The speaker will therefore deal only with such additions to or modifications of common practice as appeal to him as being of special interest and which from the standpoint of the highway departments, here represented, may be classed as recent developments. Practice varies in different sections of the country so that types and methods, which have been used for some time in certain sections, may be considered as recent developments if comparatively new or unknown to another section of the country. As this paper is purposely made brief to allow for ample discussion and as it is to be followed by a written discussion from a representative of the tar interests, only incidental reference will here be made to the use of tar, and some of the points which merit more detailed consideration will only be lightly touched upon.

Considering first what are ordinarily known as high type asphalt pavements, we have asphalt macadam, asphaltic concrete, sheet asphalt and asphalt block. As the asphalt macadam type has been brought to its highest stage of perfection by certain of the states represented in this group, there is, perhaps, nothing new which can be mentioned that is not familiar to most of those attending this Convention. However, the speaker cannot refrain from directing particular attention to the almost perfect non-skid surface now being constructed by the Massachusetts State Highway Department in its more recent work. Elimination of the heavy mat seal coat and the production of a waterproof, tightly bonded but rough texture mosaic surface, in which the large stones take all of the wear of traffic and provide a sure and safe grip for vehicle wheels, is to be especially commended.

Hot Mix Types

In connection with the hot mix types, much attention has been devoted in the last few years to investigating factors controlling the design of asphalt paving mixtures. Methods of determining the structural strength of such mixtures have been devised and are coming into quite general use as a means of evaluating their serviceability. Various factors affecting both structural strength and durability have been studied with the result that many old and faulty theories and rule of thumb methods are now being discarded and more reliance is being placed upon the characteristics of the finished mixture, than upon detailed description and specifications for the various constituents of the mix. Special attention has been devoted to sheet asphalt and fine aggregate mixtures but the governing factors of design are believed to be equally applicable to the coarse aggregate mixtures. The physical tests to which reference has been made, are known as "stability tests" and "sheer tests," which must, however, be correctly correlated with accompanying density or absorption tests. The principles of design have been quite thoroughly developed in a recent publication of The Asphalt Institute, which may be obtained upon application by any interested party. Perhaps the most important may be stated as follows:

1. The amount of asphalt which may be used safely in a mixture is limited by the per cent of voids in the compressed mineral aggregate. Any excess of asphalt which would tend to overfill the voids, will greatly decrease stability of the mixture.
2. Assuming a satisfactory degree of stability, or resistance to displacement under traffic, to exist, the more asphalt present the greater will be the durability of the mixture. As the amount of asphalt is limited by percentage of voids in the compressed mineral aggregate, it therefore follows that, when the desired degree of stability can be obtained with a relatively high void aggregate, greater durability is assured than with an exceptionally low void aggregate.
3. High stability is undesirable if obtained at the expense of durability and great durability of the mixture is of little value if the necessary degree of stability is lacking. In designing, therefore, it may become necessary to strike a balance which will insure that the mixture possesses both characteristics to a reasonable extent.

[1] Presented before the Seventh Annual Convention of the Association of Highway Officials of the North Atlantic States, Atlantic City, N. J., February 18-20, 1931.

Keeping these principles in mind and starting with any given constituents, it is now quite possible to design the most satisfactory mixture which can be produced from them by means of the tests to which reference has been made.

Recent investigations have shown that even when of the same mechanical grading and of apparently the same composition and physical appearance, two mineral aggregates may produce mixtures which behave quite differently under service conditions. Enough work has been done to strongly indicate that surface relationship between the mineral particles and the asphalt cement are responsible for this difference, which is usually disclosed by a stability test on the compressed mixture. Apparently contradictory service results, which have hitherto been unexplained, are now better understood and the possibilities of unsatisfactory results are being eliminated by intelligent application of the facts disclosed by research.

In connection with construction details of the hot mix types of asphalt pavements, the most noteworthy developments are the growing use of mechanical methods, for spreading the hot mixture so as to obtain smoother riding qualities in the newly finished pavement, and the development of a non-skid surface for the fine aggregate types by the application of a surface dressing of precoated stone chips rolled into the surface while it is still warm. Both methods have been developed and used by certain of the western states for a sufficient length of time to demonstrate their value. In California, for instance, it is standard practice in state highway construction, to require the use of a mechanical spreader in laying hot mix asphalt pavements. The method is gradually working eastward but not as rapidly as might be desired.

Perhaps the most recent development in connection with asphalt block construction is the use of a liquid asphaltic joint filler which thoroughly waterproofs the joints and also exerts a beneficial action in slightly tempering the upper surface of the block.

Cold Laid Mixtures

Various cold laid bituminous paving mixtures have been devised and promoted, many of them as patented or proprietary compositions. Such mixtures may be of the open texture, coarse aggregate type, the graded coarse aggregate type or of the fine graded aggregate type. The first of those which has been in general use for a longer period than any other, has proven highly satisfactory when properly prepared and laid with suitable constituents. For the open texture type, which most nearly resembles bituminous macadam, it is essential that a dense hard aggregate be used; that the coating of bituminous material be much thicker than is the case with graded aggregates, and that the bituminous material have a relatively low susceptibility to temperature changes. Because the mixture must be made with relatively cold aggregate in order to get the proper thickness of coating, it is moreover important that the mixing operation be conducted for a sufficient period of time to insure the most thorough possible adhesion to the aggregate surface. This is, of course, facilitated by use of a liquid primer but it is unsafe to depend upon the primer to distribute the bituminous cement over the surfaces. Without requiring special treatment, this type of cold laid mixture has the advantage of developing a non-skid surface which, if subjected to a reasonable amount of traffic in relatively warm weather, soon seals itself and becomes waterproof.

The coarse graded aggregate type possesses the advantage of more ready compressibility under traffic and less chance of displacement during the period of traffic compression than the fine aggregate type although there are some examples of cold laid mixtures, containing a regular sheet asphalt aggregate, which have developed very creditable pavements. With all of the cold laid mixtures, the surface relationship of mineral aggregate to bituminous cement is of even greater importance than in the case of the hot mix types, due to the fact that the pavement does not reach its ultimate compression for a considerable period after construction and is therefore, temporarily more subject to water action.

Low Cost Pavements

Coming now to the low cost bituminous pavements and surfaces, it is not quite so easy to classify the various types that have been developed in recent years owing to variations in practice of the different states and to the overlapping of the types themselves. Much of the work so far done is still experimental in nature and the procedure followed today has been the result of evolution of procedure extending over the past few years. Most of the low cost types employ liquid bituminous products as distinct from the semi-solid products primarily used in the high class types. These liquid products vary from non-volatile residuums through blends of residuums, to cut-back asphalts produced with various types of distillates and asphalt cements. As the methods of construction and class of aggregate have been varied in the development of such surfaces, the older specifications for liquid asphaltic products have been constantly changed until, at the present time, the situation has become chaotic, and it is difficult for engineers in one section of the country to form a correct picture of the work done in another section, due to the lack of standardization in describing or specifying the characteristics of the bituminous material which is best adapted for use. This has led to many costly experimental failures in attempting to duplicate the work of others and to a lack of appreciation on the part of one section in regard to the serviceability of some type of construction developed in some other section of the country.

One of the most far reaching recent developments, in connection with this phase of the subject, is the

series of conferences which has just been held by various groups of state highway departments under the direction of the U. S. Bureau of Public Roads, and in cooperation with the producers of liquid asphaltic products, interested in the territories represented. At these conferences, the last of which was held at Salt Lake City on February 2nd, practically all of the state highway departments and the producers pledged themselves to follow a simplified scheme of analysis, which was unanimously adopted, to apply to all liquid asphaltic products, furnished for state highway use during the present year. The data thus collected will be tabulated and distributed by the Bureau of Public Roads, to the state highway departments so as to enable them to translate into terms of the common scheme, such tests and test limits as seem most likely to insure the class of material which they wish to use in their own highway work. It is planned to hold additional conferences near the end of 1931, for the purpose of correlating the data secured and harmonizing state specifications within the individual groups insofar as it is possible to do so.

Surface Treatments, Penetration, and Mixed-in-Place Types

Although there is a great multiplicity of materials and methods now being used in low cost road work, such work may roughly be classified into surface treatments, penetration, and mixed-in-place types. For surface treatment of previously untreated roads containing an appreciable amount of fine mineral matter, double application with two distinct classes of bituminous material represents the most recent and satisfactory development. The first of these is a primer which should rapidly penetrate the surface and place it in proper condition to receive the second application of heavier, more viscous, material needed in the construction of a bituminous mat. Until recently, light tars have been the preferred primers and very soft asphalt cements the mat building materials, but recently a very satisfactory type of asphaltic primer has been developed by cutting back an asphalt cement to low viscosity with a kerosene or light furnace oil distillate. Such a distillate is preferable to use of a highly volatile naphtha which evaporates too rapidly after application and fails to carry the asphalt into the road surface. In general, use of a hard, angular, fairly large mineral aggregate fragment, is considered preferable to fine aggregate, such as sand, for surface dressing.

In the penetration or semi-penetration type of low cost road surface, a naphtha cut-back asphalt or emulsified asphalt may be satisfactorily used, provided the mineral aggregate is kept reasonably free from dust. The same is true of the mixed-in-place type of construction, known in a number of states as "retread." Where the mineral aggregate, however, contains a relatively high percentage of fine mineral matter which will pass the 200 mesh sieve, as commonly used in the western states, naphtha cut-backs and emulsified asphalts have not proven satisfactory, as they have caused balling of the aggregate with resultant lack of uniform distribution. Failure to appreciate this fact has been responsible for quite a few failures in the middle west and eastern section of the country where application of the western practice has been attempted. Bituminous material, suitable for one class of aggregate is absolutely unsuitable for the other class. As against the naphtha cut-back used in the East, the work in the West has been developed through the use of practically non-volatile residual petroleums, locally known as "fuel oils." Adoption of this term in other sections of the country would, however, be extremely misleading, owing to the difference in characteristics between the west coast fuel oils and those found elsewhere. The western class of aggregate is similar in mechanical composition to the grading of gravel in a well bonded gravel road. If the optimum amount of moisture and no more could be permanently kept in such a gravel, the road would be highly satisfactory at all seasons of the year. Experience has demonstrated that substitution of a non-volatile oil for such optimum moisture content keeps the gravel in good shape throughout the year. In the arid sections of the West and Southwest, almost any non-volatile oil of relatively low viscosity may be satisfactorily used but where moisture conditions are apt to be severe, careful selection must be made of the bituminous material to be used. There is a growing tendency to use as viscous a product as can possibly be mixed in place by means of road machines and harrows, and there is a trend toward the use of the kerosene type of cut-back in order to secure setting up characteristics which are very slow in developing in the non-volatile products. In many cases, plant mix has been substituted for road mix in this type of work at no great increase in cost and it is believed that if such practice continues and the non-volatile type of oil is used, its viscosity can be materially increased and still allow the mixture to be spread and compressed while cold. Traffic compaction is more satisfactory for such mixtures than is compaction under the roller and if during traffic compaction, the roadway is constantly bladed, a very smooth riding surface is produced. A seal coat of asphaltic material is highly desirable after the road has been thoroughly smoothed and compacted, particularly in moist climates.

In connection with all of the low cost road types, the use of mechanical means of distributing mineral aggregate, both for wearing course and cover, is a development which greatly improves the riding quality of the road. Such mechanical means may take the form of spreaders, road machines, drags or brooms, depending upon the type of work. If such machines are used, while the surface is consolidating under traffic, much smoother riding surfaces are produced than if the old hand methods of distribution are followed.

A. L. Worthen is Given Testimonial Dinner

WHEN an executive enjoys the friendship, confidence and loyalty of his employees he is a particularly fortunate individual, and when such feeling becomes so strong that it finds expression in a surprise testimonial dinner, a tribute has been paid which should be cherished through the years to come. Such was the honor bestowed upon our newly elected president, A. L. Worthen.

In 1927 there was formed by the employees of the company an organization designated as the Association of Superintendents of the Connecticut Quarries Co., Inc., for the purpose of encouraging closer social contact, harmony and cooperation between the employees, to be supplemented with educational features pertaining to the trap rock industry. From its inception the organization received the whole-hearted support and interest of Mr. Worthen as well as his entire personnel of key men consisting of the superintendents, salesmen, foremen and clerks. Since its formation, regular monthly dinners have been held to discuss business methods and offer suggestions helpful to the Connecticut Quarries Co. and the welfare of its employees. Because of his continued friendliness and cooperation towards the Association of Superintendents and because of the distinction which it was felt had been conferred upon him on his election to the presidency of the National Crushed Stone Association, the employees of the Connecticut Quarries Co. felt that they wished to show Mr. Worthen how much they had appreciated his assistance and how keenly they felt that a distinct honor had been conferred upon him by his election as the executive head of the crushed stone industry of the country.

Black Walnut Gavel and Block presented to A. L. Worthen by the Association of Superintendents of The Connecticut Quarries Co., Inc., of which he is Vice-President and General Manager

It was decided to give him a surprise testimonial dinner and that it was a surprise was clearly evident to those present upon seeing Mr. Worthen's face when he first stepped into the room. He was very much astonished to say the least. It was no small task to keep the true nature of the occasion a secret from him and he was lead to believe that he was to attend a party presumably given by friends of Mr. Edwards, General Superintendent, which was to be held in Meriden, Connecticut. The dinner was held at Waverly Inn, Cheshire, Connecticut, and in addition to the members of the Association of Superintendents invitations were sent to some twenty-five intimate friends of Mr. Worthen's.

The toastmaster for the evening was F. H. Edwards, General Superintendent. Patrick J. Kelley, President of the Association of Superintendents, with appropriate remarks, presented to Mr. Worthen on behalf of the Association a handsome gavel and block of black walnut. On the block there appears an inlaid diamond shaped design, the symbol of the Association of Superintendents, and within this in gold leaf appears the emblem of the National Crushed Stone Association. The guest speaker of the evening was Otho M. Graves, Vice-President and General Manager of the General Crushed Stone Co., Easton, Pa., and a past president of the National Crushed Stone Association. Mr. Graves paid glowing tribute to Mr. Worthen and his accomplishments and with his customary charm and wit gave a most inspiring address which will long be remembered.

At the conclusion of the dinner an excellent program of entertainment was provided. Programs of an unusual and distinctive nature were prepared in a color scheme of blue and white. On the outside cover there was placed a photograph of Mr. Worthen and on the inside cover there appeared a picture of the Capitol of Connecticut, typifying the state wherein Mr. Worthen's company operates. The unusual spirit of harmony and co-operation existing between Mr. Worthen and his organization was highly commended.

It would seem that the National Crushed Stone Association can well take pride in the fact that our new president is so highly thought of by those with whom he comes in daily contact and we wish to subscribe most heartily to the sentiment so ably expressed by the Association of Superintendents.

The Management of Credit in the Crushed Stone Industry[1]

By Wm. E. HILLIARD
General Manager, The New Haven Trap Rock Co., New Haven, Conn.

◆ The question of credit is one of paramount importance to every business man. The elements which should be considered in extending credit are very ably discussed in the following article which contains much helpful information with regard to a problem which is often perplexing. Mr. Hilliard has a background which makes it possible for him to speak with authority.

NINETY-FIVE percent of all business to-day, it is estimated, is done on credit, and only five percent on the basis of cash. The ratio of credit business to cash business is, therefore, about nineteen to one.

It is estimated, by competent observers, that the total volume of business in this country in a recent calendar year was six hundred thousand times one million dollars, a sum so vast we fail readily to grasp what it means. Imagine a city like Newark, New Jersey, and its suburbs, with about six hundred thousand inhabitants, and then try to picture every man, woman, and child in that great city each having one million dollars apiece, and it will help to visualize that enormous sum; and then consider that it would only represent one year's business in this country, and about nineteen-twentieths of all that business is done on credit. Credit is, therefore, the very foundation of our whole modern business structure; and one of the foundations of the whole modern civilization in which we live and whose benefits and advantages we enjoy. In the brief time which we can give to this broad topic to-day, it is necessary to present it only in outline. We propose, therefore, first to discuss briefly some of the general aspects of credit, and then finish with some conclusions about credit in our own crushed stone industry.

What is Credit?

One of our best modern dictionaries gives sixteen definitions of the word "credit", but none of them seem quite comprehensive and definite enough for what we mean by credit in business to-day. It is commonly considered that the best definition yet made was one worked out by a well-known authority on the subject a few years ago. Here it is:

"Credit is the power to obtain money, goods, or service by giving in exchange a promise to pay at some definite future time."

The principle, therefore, is just the same whether you borrow money on a note at the bank; or buy a bill of goods on thirty days credit; or purchase professional services of a lawyer or physician, or obtain electric light or telephone service to be paid for at a definite future date.

There are four classes of credit:

Investment Credit
Banking Credit
Wholesale Credit
Retail Credit

Investment credit is a long time proposition and is outside of our discussion to-day. It involves the investing of capital on the basis of earning dividends or interest, to be paid at intervals for a long period of time; whereas in the other three classes of credit, the purpose is to make one transaction which nets one definite profit.

Banking credit, of course, concerns the use of money itself, and has much in common with wholesale and retail credit and most of what we have to say to-day applies to banking credit as well.

The other two classes, which are wholesale credit and retail credit, are sometimes lumped together under the term of *mercantile credit*, or sometimes as *commercial credit*. We are interested to-day, particularly, in these two classes. Please note the distinction between the two. Wholesale credit is the credit used when goods are sold by one firm or individual to another for the purpose of resale. Retail credit is the credit used when the sale is made directly to the ultimate consumer. We often think of wholesale credit as being on a large scale and retail credit as being on a small scale, but the principle involved is not concerned at all with the size of the sale. A wholesale grocer sells a few cans of canned vegetables to a retail dealer on a special order and it is a wholesale credit proposition, although the sale may be much less than one dollar. A department store may furnish and equip almost completely a large new house with all the carpets, furniture, dining room and kitchen equipment, etc., amounting to several thousand dollars, but it is a sale based on retail credit because the sale is made directly to one ultimate consumer. Of course, in the long run, the average size of each sale is very much greater in wholesale business than in retail business.

It is an axiom in wholesale credit circles that credit

[1] Presented at the Fourteenth Annual Convention of the National Crushed Stone Association held at the Hotel Jefferson, St. Louis, Mo., January 19-22, 1931.

is granted on the basis of the three "C's," which are:

Character
Capacity
Capital

Character

Please note the order in which these three factors are stated. *Character* is placed first because there is no doubt that character is the most important single factor in granting credit. If you are a wholesale hardware dealer, and are considering an order from a retail hardware dealer whom you have not sold before, first of all you want to know what kind of a man he is. Has he the reputation of being over-shrewd, tricky and uncertain, inclined to find loopholes in any contracts he makes and inclined to go very close to the extreme legal limits in transactions even if he doesn't sometimes overstep the limit; or is he a man who stands morally four-square to the world, whose word is as good as his bond and who will pay his honest debts if it takes his last dollar? What kind of a man is he?

Under the play of emotions across the faces of our fellowmen—the expressions which we have come to interpret as meaning rage, delight, disgust, approbation, apathy, enthusiasm and the like,—beneath all this lies the real character of the man himself. In the long run, a man comes pretty near being just about the kind of man he is thought to be by a group of his fellowmen who have known him well for a long time. Mistakes are sometimes made. Sometimes we are shocked when some man whom many of his fellows have considered to be moral and upright in every way, does something reprehensible and we feel we have all been mistaken in sizing him up. On the other hand, sometimes a man whom many of us have not rated any too highly, suddenly displays in some crisis of his business or personal or community life, such sterling qualities that we have to say that he is a good deal more of a man than we thought he was. These, however, are exceptional cases; in the long run, the combined opinion of his fellowmen who have known him well is pretty apt to size a man up for just about what he really is.

What is character, anyway?

The best definition I have ever found is this: "Character is the sum-total of all the decisions a man has made during his entire life." That covers, you see, decisions not only on moral questions, but on questions of ordinary judgment and common sense where no moral responsibility is concerned. For in all this discussion about character, please remember that we are not concerned simply with a man's honesty. Most men are honest. Our whole system of business and of government, and in fact our whole economic and social structure is based on the assumption that most people are honest and that only a small minority are dishonest. Of course we need to know about a man's honesty, first of all; but in sizing up his character, we need to go much further and consider, for instance, whether or not he possesses courage, stability and fortitude under strain and stress. More money is lost in this country every year by business failures of men who are inherently honest, but who lack some of the other qualities which a business man must possess, than is lost by all the cases in which commercial dishonesty is involved.

Some of the older of you may recall the investigation of the so-called Money Trust in New York City many years ago. J. Pierpont Morgan, the elder, was called as a witness. A portion of Mr. Morgan's testimony on the stand was substantially as follows: The Chairman said, "Mr. Morgan, do I understand you to say that character is of vital importance when granting credit? Do you mean to say that you would consider loaning *one million dollars* to a man on the basis of his character?" Mr. Morgan replied: "I not only would, but I *have*, and more than once, and it was always repaid. In the long run, character is the finest asset there is for granting credit."

Capacity

Capacity is also important. If you are a wholesale hardware dealer considering the case of a prospective retail hardware dealer as a customer, you want to know whether he knows his line or not. Does he know how to buy and how to sell, how to hire, train and develop competent and loyal assistants, how to select stock, collect money, adapt himself to the changing tides of business and make his business pay? Lack of capacity has probably caused more business failures than any other one single factor, such as lack of adequate capital or financial depressions and the like.

Capital

Capital is of course always an important factor in credit granting in wholesale business. We need to know two things about capital. First, how much capital does the customer possess and second, how it is related to his business. If one retail hardware dealer has an invested capital of $25,000 and another dealer has $50,000, other things being equal, of course one man is twice as strong as the other in point of invested capital. In some cases, however, a man with $25,000 may be running a small snug business very efficiently, making a living for himself and his family and making some financial headway; while a man with $50,000 may be trying to do a business three or four times as big as the first man's, may have to borrow at the banks considerably more than usual seasonal borrowings and may not be making any financial headway at all. To get the right picture then, we must find out both the amount of capital a man has and how it is related to the needs of his business.

Skill in wholesale credit management comes from learning to handle these three factors in their proper perspective. Of course when a man rates high in

character and capacity and capital, there is no problem. Any office boy would know that such a man should be sold as much as possible. If a man rates low in character and capacity and capital, once again any office boy should know that such a man should not be sold anything at all on a credit basis. But when it comes to the great bulk of credit granting in between these two extremes, it is not always an easy task to know just how to estimate each customer properly. For instance, a man may rate high in character, high in capacity and low in capital. Is he a good risk or not? Each case has to be determined on its own merits but quite often such a case as this would be worthy of credit. A man who has both character and capacity is pretty sure to accumulate capital after a time, barring some accident or misfortune. Many young business men starting out with excellent character, with capacity developed by working for someone else, but with little capital of their own, eventually make good and become valuable and loyal customers for those wholesalers who have extended them credit at the start.

Suppose a man is rated high in character, low in capacity and high in capital. What sort of a risk is he? You cannot always tell until you have investigated thoroughly, but quite often such a case is a good risk. A man with character will pay his honest debts if it takes his last dollar. In this case, the man is rated high in character and has adequate capital, so that even if his business did not result successfully after a reasonable time, the loss would come out of him rather than out of his creditors. The fact that his capacity is rated low may mean that he is a young man who has not had much chance to develop capacity. Furthermore, assistants with excellent capacity frequently may be hired, so that the weak spot in this man's business may be covered reasonably well. Of course you understand a low rated capacity is a serious handicap and may be serious enough to cause you to turn down the credit application.

Of course in cases where character is rated low, it is dangerous to sell under any conditions. Possibly a man who rates low in character, high in capacity and high in capital may be considered if he needs a line of goods which the seller is very anxious to move and is finding hard to sell; but if the seller makes the sale he must remember that he is entering into a contest of wits and that the buyer is likely to endeavor to evade payment by any legal loop-hole that can be found in the contract or the bill of sale. Almost always such a case should be sold for cash only.

Now I have only scratched the surface of this topic of the three "C's", but I have said enough to indicate to you what an enormous variety of credit risks may be found in varying combinations of these three different factors, each of which may rate anywhere between very high and very low.

Retail Credits

We come now to the question of retail credits. It is commonly stated that credit is granted in the retail business on the basis of two factors which are:

The customer's will to pay.

The customer's ability to pay.

A little reflection will indicate that the will to pay in retail credit corresponds closely to the element of character in wholesale credit granting; and ability to pay in retail credit depends upon income rather than capital, whereas in wholesale credit we are concerned with capital primarily and not so directly with income itself. (The question of capacity which is a factor in wholesale credit, is not a direct factor in retail credit granting.)

Retail credit is much more a man-to-man affair than wholesale credit. The buyer and the seller are in more direct personal contact. The credit man in a retail establishment needs to have a particular ability to size up people from personal interviews and to depend somewhat less on records and information and somewhat more on personal intuition than is the case in wholesale credit.

What we want to know about a retail customer is some definite information about his income, whether he obtains it as salary or wages, or whether he obtains it as dividends or interest on investments. Also we want to know what his habits of payment are.

Credit in the Crushed Stone Industry

Having briefly outlined credit in general, let us now consider it in the crushed stone industry.

Credit problems vary greatly among crushed stone producers. Some concerns no doubt sell mainly at wholesale, while others sell mainly at retail. Some may have a few large customers who take all their product while other quarries of similar size and production may dispose of all their product by local truck deliveries to a very large number of customers, each of whom buys only a small quantity at a time.

Probably the great majority of the producers sell partly at wholesale and partly at retail. It is evident then that credit problems in our business cover a wide range; those problems in the case of any one of our producers may differ greatly from those of his fellow producers in another territory or even in the same territory.

In our business of furnishing materials, we have in our different states varying degrees of protection under lien laws or rights to file claims within a limited period such as within sixty days after date of the last delivery. In some states there is very little protection to the material man. In other states there is partial protection; and in still other states protection has been made reasonably complete. In these latter cases, it is part of a state highway contract that the contractor has to pay in full for all labor and materials furnished on that particular contract for the state, and

if he fails to do so, the bonding company is responsible.

Under these conditions, a producer may sometimes find that he would be justified in selling a certain contractor in a state where the protection is reasonably complete on state highway work, while in a neighboring state, where the protection is less adequate, the same contractor would fall a little short of being a reasonably good risk.

Sound business consists in taking reasonable credit risks. Each credit problem must be worked out to determine whether it is a *reasonable* risk or not. The old adage states, "Success is usually won only at the risk of failure". That certainly applies to credit management. While risk may sometimes be kept down to a limited degree, nevertheless some element of risk is unavoidable. We must endeavor, therefore, to take no unwarrantable risks and yet on the other hand, must be willing to accept *reasonable* business risks when necessary. We can be too rigid in granting credit and by trying hard to avoid any bad debt losses whatsoever can curtail our volume of business so much that we will not make the profit that year which we ought to make, even though we lose practically nothing in the way of bad debts. On the other hand, we can grant credit too loosely for the sake of obtaining the utmost volume and incur credit losses which will more than nullify any advantage gained by the additional volume.

For most of us a reasonable middle course between these two extremes is the best and the most profitable in the long run year after year.

Development of Credit Bureaus

As long ago as about 1850, the R. G. Dun Company and the Bradstreet Company began to operate as mercantile credit agencies, furnishing commercial ratings on firms and individuals in business. That information was based on financial statements in regard to capital, with some added information about income and profits when such information could be obtained and further information about the character and capacity of the subject. These two agencies were the first in America in their line and are still the two most important to-day.

In addition, there have sprung up among various trade groups credit bureaus to provide credit information for their members in their particular line of business. These bureaus were made up of wholesalers in the same line of business who pooled their information about retailers to whom they sold.

One of the most significant movements in recent years in credit management has been the remarkable development of wholesale credit interchange bureaus not limited to any one particular line, but serving a certain territory. Under the auspices of the National Association of Credit Men, seventy-seven wholesale credit bureaus were established in different parts of the United States. The members of these credit bureaus are mainly manufacturers, wholesalers and jobbers, who report lists of their customers to the bureau. Each member of a bureau has a designating number such as 7, 12, 19, etc. Each customer's card has numbers entered on it eventually, which numbers represent all the firms who report that they have done business with that customer. In the Connecticut Bureau, for instance, there may be a card for Henry Williams of Torrington, Conn., and on his card will appear numbers which might be 7, 12, 19, 25, 31, 47. Those six numbers indicate that six different members of the bureau have sold that customer. If some member of the bureau sends in an inquiry about Henry Williams, clerks in the bureau office check these numbers from his card and either by mail or telephone, learn from the credit departments of the six concerns indicated by number, their present ledger record and recent experience with this party. When the returns are all in, the inquirer gets a tabulated report of all this information, without knowing the identity of any of the firms who turned in the information. Furthermore, each one of those firms who supplied anything to the report, automatically gets a copy of the completed report from the bureau. You can readily see how this reciprocal system, when fully carried out, aids the bureau members in knowing when some customer or prospective customer is not paying his bills elsewhere promptly. It also makes it much more difficult for an occasional commercial crook to buy at the same time from a large number of different stores many times the amount of merchandise he usually carries, then cash in as much of it as he can quickly and leave hastily for parts unknown without paying his bills.

In *retail* credit in recent years, there has been a sudden growth of local retail credit bureaus throughout the country, more than 1,000 of them being in operation to-day. These are particularly helpful to their members on account of their quick service, because retail credit often has to be granted quickly without the time to investigate which is often possible in wholesale credit.

In the New Haven Retail Credit Bureau, operated by the Chamber of Commerce of New Haven, which Bureau serves New Haven and immediate vicinity, we have on file over 200,000 individual cards. Six trunk line telephones are in operation daily. If a member of the bureau such as a local jeweler or shoe dealer or department store wishes to know about some prospective buyer, he can call up the credit bureau and while he holds the wire, he will be given a brief statement about what information is on file regarding that customer, if the customer already has a record in the bureau. If he has no record, the bureau will endeavor to obtain information to start one. The bureau will run down quickly by telephone any references the store may transmit to it, which references have been given

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Some Aspects of The Ready-mixed Concrete Business[1]

By H. F. THOMSON

Vice-President, National Ready-mixed Concrete Association, and Vice-President, General Material Co., St. Louis, Mo.

◆ Ready-mixed concrete is commanding more and more attention in the construction field and it behooves every material producer to keep himself thoroughly informed with regard to what seems destined to become an important element in construction.

READY-MIXED concrete should not be viewed as a panacea for concreting troubles, nor as a get-rich-quick scheme. Rather, it represents one of the noteworthy improvements in building methods during our generation, and as such merits serious attention from all factors in the construction field.

This is a baby industry, which has sprung to national size within comparatively few years. As late as 1927, the Biennial Census of Manufactures did not list ready-mixed concrete. But the census in 1929 carried ready-mixed concrete, or as listed "Pre-mixed Concrete", credited with an output valued at approximately seven and one-half million dollars, which value was probably incomplete because of being listed for the first time. But even so, this value was exceeded among items in the concrete products division only by building units and concrete pipe. In the year 1930, upward of six million cubic yards of concrete were delivered by commercial companies, valued at about forty million dollars, which undoubtedly marks this as the largest division in the concrete products field.

The terms "pre-mixed" or "pre-manufactured" are sometimes preferred to the expression "ready-mixed", but regardless of which descriptive designation is used, we are referring to concrete furnished the construction organization at the job in ready-to-use condition. This is not the place to debate the relative merits of different methods of operation or types of equipment, such as central or truck-mixing operations, or agitation or non-agitation delivery. In a broad sense, all such operations represent the servicing of ready-to-use concrete and they differ chiefly in the detail of the choice of equipment.

Better Concrete

This new industry deserves credit for pointing the way toward a better technique in concrete construction generally; its fundamental justification is in offering better concrete, and not in respect to cost or convenience, although both are contributing factors to its rapidly growing favor. All ready-mixed operations should have the idea of "better concrete" as their objective. A prominent concrete engineer recently remarked with reference to the ready-mixed industry: "I believe the ultimate extent of its development is entirely dependent upon the production of quality concrete." This improvement in quality results from the use of designed mixes recognizing the characteristics of the aggregates, by accurate proportioning, by automatic and positive measurement of water, by assurance of full mixing time, and through adequate inspection and testing. The supervision and testing should be complete from the materials through to the concrete as delivered; this work should be in competent hands whether handled within the organization of the ready-mixed company or by an outside laboratory which is retained for the purpose.

Each of these features of improvement over the method of job-mixing could be discussed at length if time permitted. None are such that they could not be incorporated in the customary contractor's system of mixing at-the-job if he cared to adopt such details; but combined, they are prohibitive in expense except on very large work. Thus, a well-operated ready-mixed service offers the owner of the structure a guarantee that the quality of the concrete is superior to what was formerly thought satisfactory.

This aspect of "better quality" in ready-mixed concrete represents an extra ingredient for which the industry has not yet been able to collect in general. But as the owners and supervisors of important urban construction come to recognize the possibilities of such higher quality, there then may be expected a forceful demand for ready-mixed concrete or its equivalent. As this prospect is realized by most thoughtful producers of ready-mixed, it behooves each operator to see that his business is placed and maintained on a high level for both product and service. This consideration also requires that specifications shall be met scrupulously, even though the producer realizes that he is delivering greater strength and density and aging ability in his 1:2:4 mix than would be furnished by a 1:2:4 mix by the contractor on the job.

A Specialty Business

Carrying out such an operation requires a specialized organization in both production and sales. Us-

[1] Presented at the Fourteenth Annual Convention of the National Crushed Stone Association held at the Hotel Jefferson, St. Louis, Mo., January 19-22, 1931.

ually, the aggregate producer or the material dealer has little occasion to be versed in the finer points of concrete technique, especially as concrete is only one of the many fields to which he sells. But the ready-mixed business does demand the highest and most up-to-date technique. The business might be classified as a combination of manufacturing and jobbing; manufacturing because the properties of the product as delivered differ from those of the materials as received, although the "spread" between cost and selling price at the plant is not nearly as wide as customary with most manufacturing. Furthermore, there is required a cooperation between the concrete producer and the contractor, in order that the concrete may arrive on the job at the time and in the condition required, which is far closer than is ever thought of in connection with the usual material or manufacturing business.

The selling problem in this field is similar to that of any new specialty. There is required considerable educational and unproductive effort which must continue for years, or until this new building material is firmly established. Such effort differs widely from the distribution and jobbing of a staple line. Although a large part of the present appeal in ready-mixed concrete is convenience, it is to be expected that the ultimate appeal will be that of "better concrete." Thus, along with effort for immediate sales, the producer must develop confidence in the superiority of his product and the integrity of his organization.

Although service is a much over-used term, it is the item of paramount importance in the ready-mixed business. In this field service means not only having a quality and guaranteed product to offer, but it includes ability to deliver when, as fast, and for as long or short a time as the customer may want, and in the manner which is most convenient for the customer to handle. Ability to deliver is as important here as in the electric light business; and we all know how vital it is to have full voltage at the switch when we turn on a light or a motor.

Two features of the ready-mixed business stand out prominently as compared to the average business in what might be considered related fields; (1) there is a relatively heavy investment in equipment, and (2) there is a surprisingly low ratio in most instances, between the average and maximum output.

Heavy Investment Necessary

The size of the investment required for a ready-mixed operation has frequently been misunderstood and underestimated. Of course, if the truck equipment is not owned by the operator, the operator's investment is minimized, but this merely transfers a portion of the total investment to others; in only a few locations has such arrangement been made and its advisability may be questioned as it is doubtful if hired trucks can give as good delivery service as could the operator's own equipment. Or, if ready-mixed is added as a department in an established material business, the necessary added investment may be principally for trucks as the existing unloading and storage facilities might be adequate, but then such existing investment could be considered proportioned between the dry and the wet business. But for an independent, self-contained ready-mixed operation, the total investment for plant and trucks commonly represents from $3.00 to $5.00 per cubic yard of concrete delivered annually; it may run even higher under particular circumstances. This means that with typical delivered prices on concrete of from $6.00 to $9.00 per yard, in only exceptionally favorable situations will the annual turnover be as high as $2.00 per $1.00 invested, which in turn points to the necessity of a large volume of business, handled economically, for success.

One factor contributing to this relation of large investment for business done is the irregularity of demand for the product, namely concrete; this relation is sometimes described as "low load factor". The uncontrollable variation in orders from day to day, the necessity of being able to deliver immediately on all orders, large or small, and the influence of the weather, especially the interference of winter with many classes of construction in a large portion of the country, all mean large idle equipment time. In one representative operation with which we are familiar, the average daily output over last year was only 31% of the maximum day's output. Such relation is fairly typical, although the percentage is probably much lower in many instances.

In this respect, the ready-mixed business is much like a public utility such as a street railway or an electric light company, in that the service can not be stored but must be rendered when wanted. But there is still a distinct difference which makes the ready-mixed operation particularly difficult in that there is no opportunity for overloading, even for a brief period, as with a street car or an electric line, because the truck load cannot be increased beyond cubical capacity.

Characteristics for Success

Although this business is still young, the features we have discussed point toward certain definite characteristics of a successful operation. First, the business is fundamentally that of manufacturing a building material, but is unique among manufacturing because the product is perishable within an hour or two, and each delivery is made-to-order, frequently on very short notice. Second, the operation is a specialty, demanding technical supervision and specialized selling. Third, the investment for a proper type of service is very substantial, which means that irresponsible or fly-by-night operators should be discouraged as they will bring only grief to themselves as well as others. And, fourth, like a public utility it is very desirable to

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« « EDITORIAL » »

Nelson S. Greensfelder

IT IS with profound sorrow and a deep sense of the irreparable loss which the crushed stone industry has suffered that we here record the passing of Nelson S. Greensfelder, Publicity Director of *The Explosives Engineer* magazine and Advertising Manager of the Hercules Powder Co. of Wilmington, Delaware. Mr. Greensfelder's death took place on April 5 after an illness of but a week's duration. His many friends and acquaintances throughout the industry will be distinctly shocked to learn of his untimely death. No attempt will be made in this brief announcement to record his many acts of unselfish devotion in advancing the welfare of the crushed stone industry, as a special article commemorating his constant efforts on our behalf is being prepared for publication in a subsequent issue of the *Journal*. It does seem appropriate at this time, however, to point out that largely through Mr. Greensfelder's efforts the Manufacturers' Division of the Association was organized, and that to him more than to any other one man in the industry is due the credit for initiating the accident prevention work which has been conducted by the Association in recent years. Our deepest sympathy is extended to Mr. Greensfelder's family and to the Hercules Powder Co.

Credit in the Crushed Stone Industry

IT HAS been estimated that approximately ninety-five per cent of the business of this country is conducted on a credit basis and although no figures are at hand as to whether or not this general figure can be accurately applied to the crushed stone industry, it is certainly true that credit is one of the most important considerations entering into the marketing of crushed stone. Always an item of real consequence, it becomes of even greater significance during times of business stress.

Elsewhere in this issue there is given an article entitled, "The Management of Credit in the Crushed Stone Industry" by William E. Hilliard, General Manager of the New Haven Trap Rock Co. Mr. Hilliard, in addition to giving a very able discussion of credit management in general, has directed particular attention to the important elements involved in extending credit in connection with the marketing of crushed stone and we feel it would be distinctly advantageous to crushed stone producers to give Mr. Hilliard's article a careful reading.

Additional Copies Are Still Available

AT THE time of presentation during the sessions of our Fourteenth Annual Convention held in St. Louis last January, it was recognized by all present that Professors Nyberg and Busse in their discussion entitled, "How to Win an Argument" and that Dr. Hulbert in his paper entitled, "Mental Self Discipline Aids in Industry" had presented to us information of a most unusual and valuable nature. Hardly had the convention been concluded when there arose a strong demand for copies of these talks and in order that they might be placed in the hands of the members in a convenient form and well in advance of publication of the Annual Proceedings, these two addresses were issued in pamphlet form. Even though we realized that there would be a large demand for these pamphlets from our member companies who desired to distribute them among their employees, we felt we were more than safe in procuring one thousand copies of the former and six hundred copies of the latter. The demand, however, far exceeded our expectations and it shortly became necessary to have additional copies of each printed. At the time of going to press with this issue of the *Journal* there have been distributed 1350 copies of "How to Win an Argument" and 660 copies of "Mental Self Discipline Aids in Industry," which would seem to be an excellent measuring stick of the value of this information. A number of our member companies have apparently overlooked the extreme desirability of placing the discussion by Profs. Nyberg and Busse in the hands of each one of their salesmen and of giving general distribution among their employees to the talk presented by Dr. Hulbert. An appreciable quantity of both of these pamphlets is still on hand and it is earnestly suggested that those who have not already done so immediately advise the Washington Office as to the number of pamphlets desired. It will be remembered that the price of each is $ .10 per copy.

The St. Louis Convention Proceedings

THE work involved in publishing the Proceedings of the Fourteenth Annual Convention held in St. Louis last January is rapidly being completed. The various papers and discussions presented at this annual meeting have now all been placed in type and this volume will be ready for distribution about the first of June. As has been the custom in the past one copy of the Proceedings will be provided without charge to each

member company of the Association, both active and associate. Many companies will desire additional copies which will be available at the nominal price of $2.00 per copy.

The Annual Proceedings constitute the only volume wherein all of the interesting and valuable material presented before our annual convention is given under one cover. Further, the Proceedings represent from year to year a chronological history of the progress of our organization. They are a valuable and necessary part of the library of each member. Before finally going to press with this publication it is desirable in the interests of economy to know as closely as possible the number of copies of the Proceedings which will be needed. Consequently we wish to urge those member companies of the Association who will require additional copies to notify the Washington Office immediately as to the number needed.

Quarrying Accident Rate Lower in 1930

A REDUCTION of thirteen per cent in the accident rate for the stone-quarrying industry of the country in 1930 has just been announced by Scott Turner, Director of the United States Bureau of Mines, Department of Commerce. Mr. Turner's statement is based upon reports which the Bureau of Mines has received from quarry operators that employ nearly three-fourths of the total number of men employed at all quarries in the United States. The reports cover the quarrying and crushing of stone and the manufacture of lime and cement, as well as rock-dressing done at the quarries.

A special tabulation of returns from operating companies received by the Bureau up to April 18th, shows that accidents in 1930 occurred at a rate of 106 accidents for each thousand men employed. Reports from the same plants for the previous year showed 122 accidents per thousand men employed. The fatality rate during 1930 at these plants was 1.51 and the injury rate was 105 per thousand men employed. Corresponding reports for the same plants in the preceding year showed a fatality rate of 1.63 and an injury rate of 121. These figures cover all injuries that disabled an employee for more than the remainder of the day on which the accident occurred.

Comparative figures for 1929 and 1930 for identical plants show that in 1930 there was a reduction of a little over three per cent in the number of men employed and a reduction of more than nine per cent in the total number of manshifts worked. The average working time per employee at these plants was 256 days in 1930 as compared with 274 days in 1929.

Complete figures covering the entire quarry industry in the United States will be issued by the Bureau of Mines as soon as the Bureau has received reports from the small number of companies that have not as yet sent in their returns for 1930. The final figures to be published will give more detailed information regarding accidents that occurred at the quarries.

A. S. T. M. to Have Exhibit of Testing Apparatus and Machines

FOR the first time in its history the American Society for Testing Materials will sponsor an Exhibit of Testing Apparatus and Machines in conjunction with the Annual Meeting of the Society, at The Stevens in Chicago, June 22-26. The Exhibit has been planned with a view to having a distinctly scientific and broadly educational atmosphere which will be consistent with the technical nature of the Society's activities.

The Exhibit is limited to equipment and apparatus used in the testing of materials and products, and recording and control equipment which is used in testing will be shown. Testing machines of all types, metallographic and optical equipment, certain chemical and physical testing equipment, and specialties—for example, sieves, pyrometric apparatus, fatigue machines, etc., will be in the displays of the leading companies in these fields. Manufacturers, distributors, and representatives of foreign companies will have equipment on display which covers practically all phases of the testing field.

The Exhibit will afford the Society membership and others an opportunity to acquire first-hand knowledge of available equipment, especially of newer types and developments. Some companies are planning to show for the first time testing equipment which they have developed. This should prove of great interest to all Exhibit visitors.

A feature of the Exhibit will be the participation in it of certain of the Society's committees. Some of these have signified their intention of showing apparatus which they have developed for special tests in conjunction with the work of their specific committee. Government, institutional, and private laboratories are expected to participate in the Exhibit; many of these have specialized equipment (not commercially produced) which they have designed and developed for some specific test or determination. Both the committee exhibits and those of research laboratories should attract unusual attention since it is seldom that their highly specialized apparatus is put on display for the public to see. The A. S. T. M. Exhibit thus affords a splendid opportunity to view these interesting pieces of apparatus.

With leading firms in the industry represented; with A. S. T. M. committees showing highly specialized apparatus; and several outstanding research laboratories displaying equipment they have devised; an unusual and highly interesting Exhibit is looked for.

« « Manufacturers' Division—New Equipment Section » »

C. H. Adamson to Head Stephens-Adamson Conveyor Sales in Chicago District

C. H. Adamson, newly appointed Chicago District Manager for Stephens-Adamson.

Stephens - Adamson Mfg. Co., conveyor and screen manufacturers of Aurora, Illinois, have enlarged their Chicago office and moved to new quarters in the Civic Opera Building at 20 North Wacker Drive. C. H. Adamson, Secretary of the firm, will be in direct charge of sales and engineering for the Chicago territory.

A confidence in the growing importance of Chicago as a manufacturing center is given as the reason for the increased sales and engineering staff.

C. H. Adamson, the new District Manager, is well known in the district, having been director of all Stephens-Adamson advertising and sales promotional work for many years. He is a graduate of Carnegie Institute of Technology and an engineer of experience and unquestioned ability.

Traylor Engineering and Manufacturing Co. Moves New York Office

We have just been advised that on and after May 1 the New York Office of the Traylor Engineering and Manufacturing Co. in charge of Mr. R. R. Shafter will be removed from 30 Church Street to Room 2513 Empire State Building. We also wish to call attention to Bulletin No. 110 recently issued by this company describing in detail the specifications and operation of Type TZ Reduction Crusher, manufactured by this company. Copies of this bulletin will be forwarded to interested parties upon request.

New Heavy-Duty Engine Added to Linn Tractor Line-up

To meet the growing demand for a slow speed engine of the heavy-duty type, the Linn Manufacturing Corporation of Morris, N. Y., announces a new model HS four-cylinder Waukesha engine to be furnished with all 4-28-D Linn Tractors.

Characteristics of the HS model used in 4-28-D machines and of its brother, the 6-AB six-cylinder engine used in 6-28-D machines, are roughly compared as follows:

	Governed Speed	H.P. Developed	Weight	Tractor Speed in Miles per Hour
HS	1050 RPM	73	1575	5
6AB	1500 RPM	90	1500	7.15

All units in these two models, except the motor, front propeller shaft and transmission, are interchangeable, affording unusual advantages to the contractor or county with Linns in operation. On long hauls of 2000 feet or more, the six-cylinder model with its greater speed, shows up to an appreciable advantage. On shorter hauls from 700 to 800 feet, where the difference in speed is of little importance, the four-cylinder model has a lower first cost, longer life in all wearing parts and lessened maintenance and up-keep.

P & H Announces A New One Yard Excavator Moves New York Office

A new improved, full revolving one yard excavator known as the P&H Model "500", is just announced by Harnischfeger Corporation. This machine, which "spent the winter" working in the test field is now being put into production to be ready for delivery at a very early date.

The "500" follows the general proven P&H design with a number of added refinements. Main frames are unit alloy steel castings. Wearing parts are of alloy heat treated steels. Drums are in tandem and operate through the P&H power clutch control. A minimum number of gear reductions makes this new machine extremely simple. Sturdy gasoline, Diesel, or electric motors provide ample power whether the machine is used as shovel, dragline, crane, clamshell, hoe, or skimmer.

Corduroy (crawler) frames are cast from alloy steel and are bolted directly to the carbody. The crawlers on the "500" employ the P&H double spocket drive directly engaging the link pins. Twelve pairs of alloy heat treated rollers distribute the weight of the machine through the corduroy shoes to the ground. Corduroy shoes of various widths can be provided to meet different ground conditions.

The patented P&H chain crowd with fast return is used on the Model "500." Shovel boom is of sturdy, box-section construction. A one cubic yard dipper with manganese steel front and renewable reversible teeth is standard.

Dragline and crane booms are of trussed structural design. Equipped for dragline operation, the Model "500" handles the one yard bucket on a 40′ boom. As a crane with the same length boom, it is rated at 31,700 lbs. at 12′ radius, which is 75% of the tipping load.

A substantial, fully enclosed steel cab is standard on this new P&H. The entire machine is finished in attractive dark green enamel.

A bulletin describing the P&H Model "500" may be obtained by either writing to the Main Office of Harnischfeger Corporation at Milwaukee or to any branch office.

Harnischfeger Sales Corporation also wishes to announce The Empire State Building as the new address of the Harnischfeger New York Office. Removal from the old offices in the Hudson Terminal Building, 50 Church Street, took place April 27. The new offices are on the 25th floor of the Empire State Building, and are in keeping with the beauty and convenience of this new, widely known office location.

The Management of Credit in the Crushed Stone Industry

(Continued from page 20)

by the prospective buyer. With a little more time, the bureau will check up the applicant's business connections in reference to salary or wages earned if he or she is employed somewhere. If the applicant has recently moved to New Haven from another city, or district covered by a local bureau such as Springfield, Mass., or Syracuse, N. Y., the New Haven Bureau will communicate by mail or possibly by telephone with that other bureau and through this reciprocal method, frequently can learn a good deal about the applicant.

These retail interchange bureaus can aid their members to determine the proper rating of the applicant's "ability to pay", and "will to pay". The wholesale interchange bureaus can aid their members to determine the proper rating of the applicant as to "Character, Capacity and Capital."

Some producers in our line may now be making use of either such wholesale credit bureaus or retail credit bureaus as may be located in their territory. Others who have not followed up the work of these bureaus in recent years may be interested to investigate and see if they could not profit by joining them. These bureaus in the last few years have become vastly more efficient than they were even a few years ago.

The time has apparently not yet come when any organized bureaus would be effective in our industry alone. It is possible that in the future our industry may follow the practice of some other industries, where the need for bureaus is no doubt greater, and find it possible to do something in this line. Of course many individual producers have cooperated on friendly terms with their competitors by exchanging occasional items of credit information in an informal fashion.

I presume all of us present at this meeting to-day who take any part in credit granting have had the experience of sometimes letting some of our competitors know about customers of ours who have suddenly gotten in bad shape financially; and conversely many of us have had the experience of receiving occasional items of information from other producers so that when a certain customer came to buy from us, we knew in advance that his only reason for coming to us was because he had been shut off somewhere else for not paying his bills. Among all the other activities of our local associations and National Crushed Stone Association it may be possible in the future to develop this informal assistance to one another into more definite, concrete and organized form through central bureaus.

On the other hand it may be that in the future we can do better to join some of the bureaus already established which would have reports about our prospective customers not simply from other stone producers, but from many other lines of business as well, such as cement, steel, asphalt, contractors outfits and the like. In either case, I believe we are likely to see credit handled far more scientifically in the future than has been possible up to the present time.

Important Considerations in Granting Credit

There are two considerations we should bear in mind when granting credit in our line. In the first place, when we refrain from granting credit to those prospective customers whose records show that they are not worthy of credit, we are aiding the industry in general by improving the whole pattern and fabric of our business methods. In the second place, it is not fair that those customers who are sound credit risks and who pay their bills with reasonable promptness and regularity should have to compete with unsubstantial and unreliable customers any more than is absolutely necessary. If we are too lax in credit granting, we are only encouraging these undesirable customers to continue in business where they have no real right to be and from where it is only a question of time when they will be ultimately forced out.

We saw at the beginning of our talk to-day that "Credit is the *power* to obtain money, goods, or service by giving in exchange a promise to pay at some definite future time".

We should try to see that such real, undoubted power be not bestowed by us to unworthy customers; but that it *be* supplied to those sound and dependable customers of ours on whom the final success of our business depends, in the long run.

Highways and Vehicles Valued at 30 Billions

THE value of highways and motor vehicles is now around thirty billion dollars, according to figures of the American Road Builders' Association, exceeding the reproduction value of twenty-six billion dollars for railroad roadbed, terminals and rolling stock. The annual highway operating cost is believed to be in excess of eight billion dollars. This puts highway activities in first place with double the annual volume of expenditures of the national government.

Analyzing the figures, the cost of reproduction of pavements, grading and bridges on roads and streets is estimated at $14,771,000,000. Federal aid and state highways (208,000 miles) are valued at $4,550,000,000; surfaced county and local roads (454,000 miles) at $4,540,000,000; unimproved dirt roads (2,363,000 miles) at $1,181,000,000; city streets (200,000 miles estimated) at $4,500,000,000.

The cost of right of way, estimated as the cost of obtaining easements only, is around a billion dollars.

Vehicles and garages are estimated at present value. The 3,400,000 motor trucks valued at $500 each amount to $1,700,000,000; 23,100,000 automobiles at $400 each amount to $9,240,000,000; garages and terminals are

estimated at $4,000,000,000; total, $14,940,000,000 for motor vehicles and garages.

The total for highways, right of way and vehicles is $30,711,000,000.

The annual operating cost of highway transportation to the users is believed to be around eight billions. This is divided into registration fees, $348,000,000; gasoline consumption of fourteen billion gallons at 15 cents a gallon, $2,100,000,000; depreciation at around 15 per cent annually, $1,641,000,000; oil, insurance, interest, tires, etc., estimated at $4,000,000,000; total, $8,089,000,000 annual expense to users of motor vehicles, or $300 a year for each vehicle.

To the public, the highway operating cost of maintenance, administration and interest, deducting $800,000,000 taxes paid by motor vehicle users, is not more than $200,000,000 annually.

New construction of roads and streets (betterments) appears to be around $1,500,000,000 annually added to the highway investment.

Based on an average gasoline consumption of 12 miles per gallon, motor vehicles run over 168 billion miles annually; average annual mileage, about 6,300. If one vehicle could travel to the sun ninety-three million miles away, it would make 903 round trips each year to equal the mileage of motor vehicles in the United States.

Some Aspects of The Ready-mixed Concrete Business

(*Continued from page 22*)

have in each metropolitan district at least one large operator, as he can meet the diversity of demand more efficiently than a number of smaller operators having even a greater amount of total equipment.

But the full recognition and application of these characteristics is hardly to be expected so soon. The ready-mixed concrete business has gone through and will continue to go through many transitions before becoming standardized. But while working out its destiny, we believe that the chief justification for the present use and expected expansion, is that the ready-mixed operation has pointed the way toward securing better concrete for the ordinary construction job in our larger cities.

Simultaneous Action

As far as the eye can tell by observing the above photo, the thirteen drill holes are acting together to break the face of rock down uniformly. This simultaneous action helps breakage. Furthermore, Cordeau-Bickford gives you a detonator which is insensitive to friction or ordinary shock.

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